[0030] The thin-film structure may include a plurality of thin-film layers, and the plurality of thin-film layers may be stacked in a direction of a thickness of each of the plurality of thin-film layers.

[0031] Each of the plurality of thin-film layers may include $Bi_{0.5}Sb_{1.5}Te_3$.

[0032] The buffer layer may include a first buffer layer on the oxide substrate and including tellurium oxide, and a second buffer on the first buffer layer and including Te.

[0033] A thickness of the buffer layer may be about 0.2 nm to about 2 nm.

[0034] According to some example embodiments, a thermoelectric device includes a thermoelectric structure. The thermoelectric structure may include a substrate and a thin-film structure on the substrate. The thin-film structure may include tellurium (Te). Heat conductivity of the thin-film structure in a direction of thickness of the thin-film structure may be about 0.14 W/(m.1) to about 0.3 W/(m.3). A full width at half maximum (FWHM) of the thin-film structure may be equal to or less than about 0.1 degrees.

[0035] The thermoelectric device may include a power apparatus coupled to the thermoelectric structure through one or more electrical leads. The power apparatus may be configured to supply electrical current to the thermoelectric structure. The thermoelectric structure may be configured to generate a temperature gradient between opposite ends of the thermoelectric structure based on the supplied electrical current.

[0036] The thermoelectric device may include an electronic apparatus coupled to the thermoelectric structure through one or more electrical leads. The thermoelectric structure may be configured to induce an electrical current through the electronic apparatus based on a temperature gradient between opposite ends of the thermoelectric structure.

[0037] The thin-film structure may include a plurality of thin-film layers. The plurality of thin-film layers may be stacked in a direction of a thickness of each of the plurality of thin-film layers.

[0038] Each of the plurality of thin-film layers may include $Bi_{0.5}Sb_{1.5}Te_3$.

[0039] According to some example embodiments, a thermoelectric structure includes a buffer layer and a thin-film structure on the buffer layer. The buffer layer may include tellurium oxide. The thin-film structure may include a plurality of thin-film layers that may be stacked in a direction of a thickness of each of the plurality of thin-film layers. The thin-film structure may include a plurality of thin-film layers that may be stacked in a direction of a thickness of each of the plurality of thin-film layers. The thin-film layers may include tellurium.

[0040] The thin-film structure may have a thickness that is about 10 nm to about 100 nm.

[0041] The thin-film structure may have a heat conductivity in a direction of a thickness of the thin-film structure. The heat conductivity may be about 0.14 W/(m(m) to about 0.3 W/(m0.).

[0042] The thin-film structure may have a full width at half maximum (FWHM) that is equal to or less than about 0.1 degrees.

[0043] The buffer layer may include a first buffer layer on the oxide substrate and a second buffer layer on the first buffer layer. The first buffer layer may include tellurium oxide. The second buffer layer may include tellurium (Te).

[0044] Each of the plurality of thin-film layers may include $Bi_{0.5}Sb_{1.5}Te_3$.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] These and/or other aspects will become apparent and more readily appreciated from the following description of example embodiments, taken in conjunction with the accompanying drawings in which:

[0046] FIG. **1**A and FIG. **1**B illustrate a thermoelectric device according to some example embodiments;

[0047] FIG. **2** is a conceptual diagram of a cross-sectional view of a thermoelectric structure according to some example embodiments;

[0048] FIG. **3** is a flowchart of a method of manufacturing a thermoelectric structure according to some example embodiments;

[0049] FIG. **4** is a flowchart illustrating a method of manufacturing a thermoelectric structure according to some example embodiments;

[0050] FIG. **5** illustrates an image obtained by observing a manufactured thermoelectric structure by using an optical electronic microscope, according to some example embodiments;

[0051] FIG. **6** is a graph showing a result of measuring a chemical element in a direction of a thickness of the thermoelectric structure according to energy dispersive X-ray (EDX) spectroscopy analysis, according to some example embodiments;

[0052] FIG. **7**A, FIG. **7**B, and FIG. **7**C are graphs showing results of two-theta (2θ) scanning, omega (Ω) scanning, and phi (ϕ) scanning of the thin-film structure **40**, respectively;

[0053] FIG. **8**A illustrates a conceptual diagram of a measuring apparatus for measuring heat conductivity of the thin-film structure, according to some example embodiments;

[0054] FIG. **8**B is a photograph of the measuring apparatus shown in FIG. **8**A, taken in a downward direction from above;

[0055] FIG. **9** is a graph showing a state of the measuring apparatus shown in FIG. **8**A;

[0056] FIG. **10** is a graph showing heat conductivity of the thin-film structure according to some example embodiments;

[0057] FIG. **11** is a flowchart illustrating a method of manufacturing the thermoelectric structure according to some example embodiments;

[0058] FIG. **12** illustrates a schematic diagram of a separated thin-film structure according to some example embodiments; and

[0059] FIG. **13** illustrates a schematic diagram of a thermoelectric device in which the separated thin-film structure is disposed on a substrate according to some example embodiments.

[0060] It should be noted that these figures are intended to illustrate the general characteristics of methods and/or structure utilized in certain example embodiments and to supplement the written description provided below. These drawings are not, however, to scale and may not precisely reflect the precise structural or performance characteristics of any given embodiment, and should not be interpreted as defining or limiting the range of values or properties encompassed by example embodiments.